MULTIMEDIA UNIVERSITY

**STUDENT ID NO**

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# MULTIMEDIA UNIVERSITY

# FINAL EXAMINATION

**TRIMESTER 1, 2016/2017**

## TCV3151 – COMPUTER VISION
( All sections / Groups )

13 October 2016
9:00 a.m. – 11:00 a.m.
(2 Hours)

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**INSTRUCTIONS TO STUDENTS**

1. This question paper consists of 6 pages with 5 questions only.
2. Attempt **ALL** questions. All questions carry equal marks and the distribution of the marks for each question is given.
3. Please print all your answers in the answer booklet provided.

## QUESTION 1

(a) Describe the following basic modules in designing a computer vision system:

(i) Image pre-processing
(ii) Segmentation

[2 marks]

(b) Suppose that a flat area with center at $(x_0, y_0)$ is illuminated by a light source with intensity distribution

$$i(x,y) = Ke^{-[(x-x_0)^2+(y-y_0)^2]}$$

Assume for simplicity that the reflectance of the area is constant and equal to 1.0. Form the model for the digital image $f(x,y)$ constructed using the lighting configuration given $K = 255$.

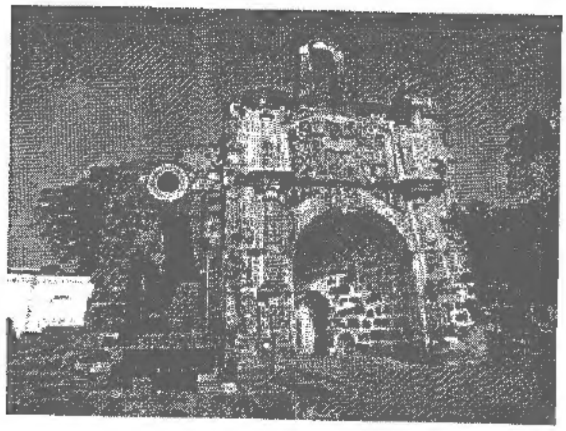
[2 marks]

(c) Consider a digitized image of the A Famosa fortress. Calculate the number of bits that are required to store the image.

[2 marks]

$j$=1 → Width 620

$i$=1



580 Height

Intensity: [0, 128]

(d) Consider the image segment shown below.

$$\begin{array}{rcccccl} & 3 & 1 & 1 & \boxed{1} & \rightarrow q \\ & 2 & 2 & 2 & 0 & \\ & 2 & 0 & 3 & 1 & \\ p \rightarrow & \boxed{1} & 1 & 2 & 3 & \end{array}$$

(i) Let $V = \{0,1\}$, compute $D_4$-, $D_8$-, and $D_m$-distances between $p$ and $q$.

[3 marks]

(ii) Calculate the $D_m$-distance between $p$ and $q$ for $V = \{1,2\}$.

[1 mark]

**Continued .......**

## QUESTION 2

(a) Compare and contrast smoothing and sharpening filters. [3 marks]

(b) Figure 2.1 depicts the original image that was filtered using a smoothing filter. The filtered result is shown in Figure 2.2. The filter used was one of these: (1) average filter; (2) Gaussian lowpass filter; (3) median filter. The small black square on the lower right hand corner of the original image shows the size of the mask that was used. That small square is not part of the image.

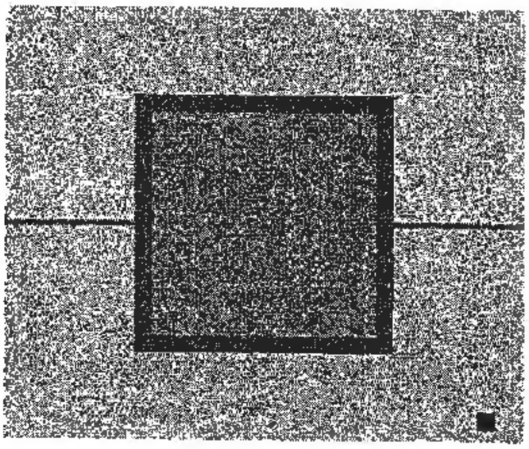


Figure 2.1

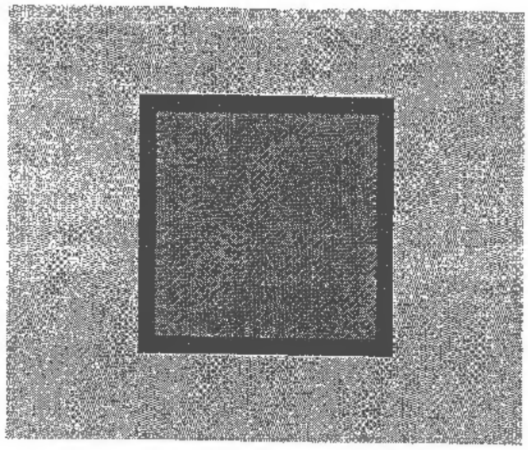


Figure 2.2

(i) For each of the three possible filters listed above, give at least one reason why you think it was, or was not, the filter actually used.

[3 marks]

(ii) If the size of the mask were tripled, and the same filter you selected in (i) was used, how would the appearance of the image be after the filtering process?

[2 marks]

(iii) What will you obtain if the average filter is applied on the original image again and again? What happen if the median filter is applied instead?

[2 marks]

Continued .......

## QUESTION 3

(a) Figure below shows the image of a lady which has been corrupted by digital noises. Identify the type of noise that exists in the image and explain how this noise can be removed.

[3 marks]

(b) Figure 3.1 shows a 3-bit image of size 5-by-5; while Figure 3.2 and Figure 3.3 illustrate a Laplacian and a low-pass filters, respectively.

| | | | | |
|---|---|---|---|---|
| 3 | 7 | 6 | 2 | 0 |
| 2 | 4 | 6 | 1 | 1 |
| 4 | 7 | 2 | 5 | 4 |
| 3 | 0 | 6 | 2 | 1 |
| 5 | 7 | 5 | 1 | 2 |

Figure 3.1 Original image

| | | |
|---|---|---|
| 0 | 1 | 0 |
| 1 | -4 | 1 |
| 0 | 1 | 0 |

Figure 3.2 Laplacian filter

| | | |
|---|---|---|
| 0.01 | 0.1 | 0.01 |
| 0.1 | 0.56 | 0.1 |
| 0.01 | 0.1 | 0.01 |

Figure 3.3 Low-pass filter

(i) Compute the output of the $3 \times 3$ Laplacian filter at the center of the original image (the location highlighted in grey). [2 marks]

(ii) Compute the output of the $3 \times 3$ low-pass filter at the same position. [2 marks]

(iii) Apply histogram equalization on the image and show the output of the operation. Assume the grayscale values range from 0 to 9. [3 marks]

Continued .......

## QUESTION 4

(a) Describe the two approaches to partition an image into regions. [2 marks]

(b) Figure 4.1 shows the histogram of an original image depicted in Figure 4.2. The binary images illustrated in Figure 4.3 are the results after applying thresholding on the original image using different threshold values, $T$.

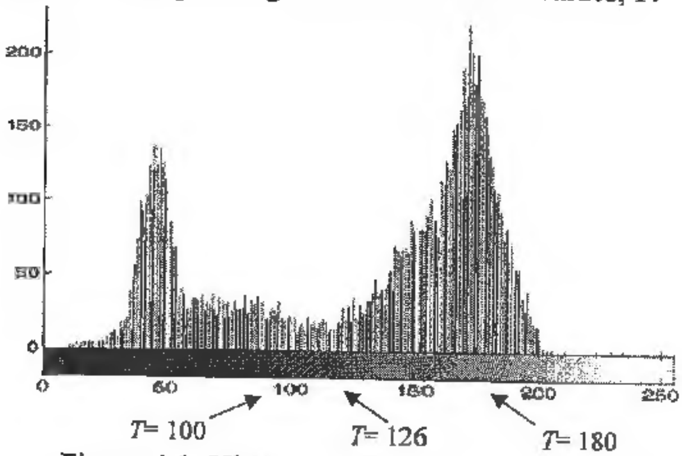



Figure 4.1. Histogram of the original image.

Figure 4.2. Original image.

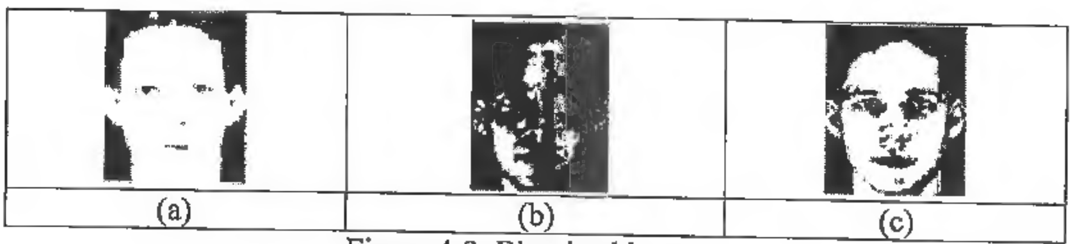



Figure 4.3. Binarized images.

(i) Explain the thresholding method. [1 mark]

(ii) For each of the binarized image shown in Figure 4.3, give the threshold value, $T$, that you think yielded the result. Explain your answer. [3 marks]

(c) Consider a matrix A below which is the result of applying run-length encoding on a binary image of size 3 pixels × 15 pixels. Recover the original image assuming the length of runs approach was used in the compression process.

$$A = \begin{bmatrix} 2 & 1 & 2 & 4 & 1 & 1 & 2 & 1 & 1 \\ 0 & 4 & 2 & 1 & 1 & 7 & 0 & 0 & 0 \\ 3 & 6 & 2 & 4 & 0 & 0 & 0 & 0 & 0 \end{bmatrix}$$

[4 marks]

**Continued .......**

## QUESTION 5

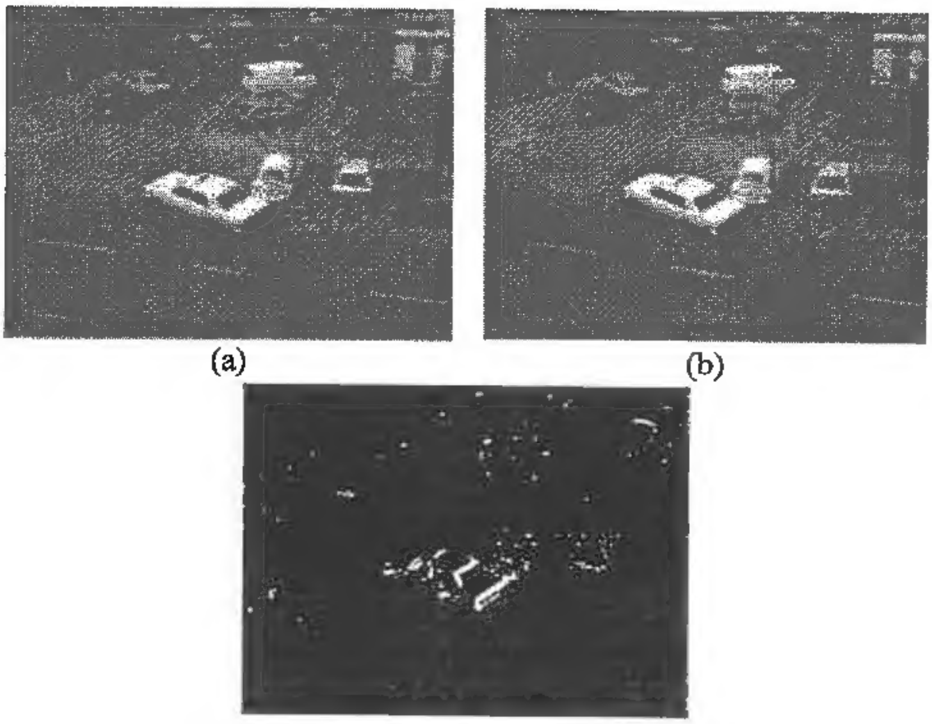
(a) Consider the image below. Find the gray-level co-occurrence matrix if the position operator "1 pixel to the right and 1 pixel down" is used. [2 marks]

| | | | | |
|---|---|---|---|---|
| 0 | 0 | 0 | 1 | 2 |
| 1 | 1 | 0 | 1 | 1 |
| 2 | 2 | 1 | 0 | 0 |
| 1 | 1 | 0 | 2 | 0 |
| 0 | 0 | 1 | 0 | 1 |

(b) Figure 5.1(a) and (b) depict two image frames of a traffic intersection. The first image is considered the reference, and the second depicts the same scene some time later. Your objective is to detect the moving car in the scene. You apply the following equation for this purpose:

$$f(x) = \begin{cases} 1, & |F(x,y,j) - F(x,y,k)| > \tau \\ 0, & \text{otherwise} \end{cases}$$

The output of the operation is shown in Figure 5.1(c). Observe the output and explain why such result is obtained. [2 marks]



(a) (b)

(c)

Figure 5.1

**Continued .......**

(c) Briefly explain two distinct limitations of the sliding window-based approach to object detection.

[2 marks]

(d) When would detecting corners be more appropriate than detecting edges as an initial step in an application using computer vision?

[2 marks]

(e) Explain the processes in a bag-of-words category recognition system. Use a diagram in your answer if necessary.

[2 marks]

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